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Lessons to Learn: An Analysis of OSHA-Investigated Fall Fatalities in the U.S. Construction Industry, 2015-2019

James L. Jenkins, CHST
Purdue University
West Lafayette, Indiana USA

Sonya Meekel
Technological University Dublin
Dublin, Republic of Ireland

Abstract

Falls remain the leading killer in the U.S. construction industry. Despite the recurring nature of fall-related fatalities, the construction industry seems to struggle with learning from past incidents. Between 2015 and 2019, over 37% of all construction fatalities (1,902 out of 5,172) were fall-related. This research study aims to analyze Occupational Safety and Health Administration (OSHA) investigations of fall-related fatalities in the construction industry during this 5-year period to identify trends and patterns of these fatal occurrences. More than 40% of the fatality investigations conducted by OSHA between 2015 and 2019 involved falls. Of these falls, roofing contractors accounted for over 25% of all fall fatalities, many of which were in the *falls from roofs* category. This study identified 20 types of work activities that preceded the construction fall fatalities investigated by OSHA. Industry professionals and academia can leverage the "lessons learned" from this paper to develop training programs that reduce the likelihood and severity of *falls from height* on construction sites.

Key Words: OSHA, falls, focus four, construction safety, safety training

Introduction

Construction is a hazardous industry with many occupational hazards (Brown et al., 2021). Workers often work at elevated heights and in challenging environments, making construction riskier than other industries for worker health and safety (OSHA, 2012). Between 2015 and 2019, the construction industry accounted for 20% of all workplace fatalities in the United States, while only employing around 6% of the workforce (CPWR, 2016). According to the U.S. Bureau of Labor Statistics (BLS), 5,172 U.S. construction workers died on the job between 2015 and 2019 (BLS, 2021b). Based on these numbers, three construction workers are killed, on average, each day.

OSHA has identified the four leading causes of fatalities in the construction industry: *caught in or between, electrocution, fall, and struck by an object or equipment* (OSHA, 2011). These causes are commonly referred to as either OSHA’s “Focus Four Hazards” or as the “OSHA Fatal Four Hazards”. A description for each of these top-4 hazards is listed in Table 1.

Table 1

OSHA fatal four hazards

Hazard Type	Example Situations
Caught-in/Between Hazards	trench cave-in, run-over/roll-over by equipment, caught-in equipment, crushed by material/equipment, asphyxiation, inhalation of toxic vapor
Electrocution Hazards	shock by touching exposed wires, shock by equipment/tool contacting power source
Fall Hazards	fall from ladder, fall from roof, fall through skylight, fall through unguarded floor opening, fall from structure
Struck-by Hazards	struck-by highway vehicle/construction equipment/falling material, power saw kick-back

Falls historically remain the leading cause of all deaths in construction, while struck-bys and electrocutions, and caught-in/betweens are responsible for the second, third, and fourth most fatalities respectively (Brown, et.al, 2021). Falls accounted for 37 percent, or 1,902 of the 5,172 fatalities in 2015-2019. The trends for the fall fatalities between 2015 to 2019 are shown in Figure 1 (BLS, 2021a).



Figure 1. Fatal falls in the U.S. construction industry, 2015 to 2019 (BLS, 2021a).

Although the percentages and number of fall fatalities offer valuable information, they lack the depth necessary to grasp the work-related circumstances surrounding these tragedies. This paper addresses this gap by providing detailed information on these fatal fall events.

Literature Review

After a comprehensive review of recent safety-related literature, it was established that limited research exists on identifying specific events that lead to fall-related fatalities in construction. Of these studies, only two utilized a similar research approach and analysis discussed in this paper. Huang and Hinze (2003) and Kang et al. (2017) examined the OSHA inspection database and conducted focused studies to determine if there was a pattern for fatal fall accidents among construction workers. Huang and Hinze analyzed OSHA investigation data for 1990-2001, while Kang et al. focused on the data for 1997-2012. Amongst the different variables discussed in these two studies, the Huang & Hinze study found ten (10) fall hazards events while the Kang study identified nine (9) types of fall events. These events include designations such as *fall from roof*, *fall from scaffold*, and *fall from ladder*.

Studies by Huang and Hinze (2003) and Kang et al. (2017) found that falls account for a significant portion of construction fatalities investigated by OSHA (36.3% and 44.6%, respectively), with most falls (70% and 80%, respectively) occurring at elevations below 30 feet. Additionally, both studies found that *falls from roofs* are a common type (28.4% and 24.7%, respectively) of investigated fall accidents.

The recurring nature of construction fatalities underscores the industry's persistent failure to learn from past incidents and implement effective preventive measures. Building upon the work of Huang and Hinze and Kang et al., this study analyzed OSHA investigation data to examine trends in all types of construction fatalities from 2015 to 2019. As a result of this study, *sixty (60) causes* of fatal injuries for U.S. construction workers were identified, of which 20 were falls. This paper will examine the 20 primary causes of fatal falls among U.S. construction workers, as identified by OSHA's fatality investigations.

Research Methodology

OSHA investigates most work-related fatalities and summarizes each incident in an *OSHA 170 Fatality and Catastrophe Investigation Summary* form. In September 2020, the authors used a Freedom of Information Act request to get OSHA inspection data for construction worker deaths from 2015 to 2019. By focusing on pre-pandemic data (2015-2019), this study aims to provide an objective assessment of underlying trends in construction fatalities, free from the potential bias introduced by pandemic-related disruptions that occurred in 2020 and 2021.

The OSHA Directorate of Construction provided the data as a *Microsoft Excel*® spreadsheet file in May 2021. The dataset for the five-year period included 2,938 lines of data, corresponding to the 2,814 construction fatalities that were investigated during that time. Microsoft Excel® spreadsheet software was used to sort and organize this information. The OSHA inspection report dataset included the following elements:

- OSHA Inspection number for each fatality investigation
- North American Industry Classification System (NAICS) number of companies/industries
- Incident date and time
- Total number of fatalities for the incident
- Description of fatal event with keywords

To classify the type of fatality for each incident, the detailed descriptions in the OSHA 170 inspection forms were reviewed. This was accomplished by entering the inspection number from the dataset into the *OSHA Inspection Information Search* website (OSHA, 2023), which provided the details of each inspection.

Overall, OSHA investigated 2,759 construction fatality events that accounted for 2,814 fatalities (there were 55 multiple fatality events) between 2015-2019. Each of the investigated fatalities were categorized by Jenkins (2022) as either a *Fall* (41.1%, or 1,158 out of 2,814), *Struck-By* (15.25%, or 429 out of 2,814), *Caught-in/Between* (20%, or 562 out of 2,814), Electric Shock (11.4%, or 320 out of 2,814), or as an *Other* (12.25%, or 345 out of 2,814) event based on the descriptive narrative provided in each of the *OSHA 170 Fatality and Catastrophe Investigation Summary* forms. An in-depth analysis of OSHA 170 inspection forms resulted in the categorization and sorting of OSHA-investigated fatalities into 60 detailed fatality event types based on the provided accident descriptions.

Study Results

The study presented in this paper focuses on the 1,158 fall fatalities investigated by OSHA during the 5-year period and the 20 specific fall-related events that lead to these fatalities. The list of the twenty detailed 'fall' events are shown in Table 2.

Table 2

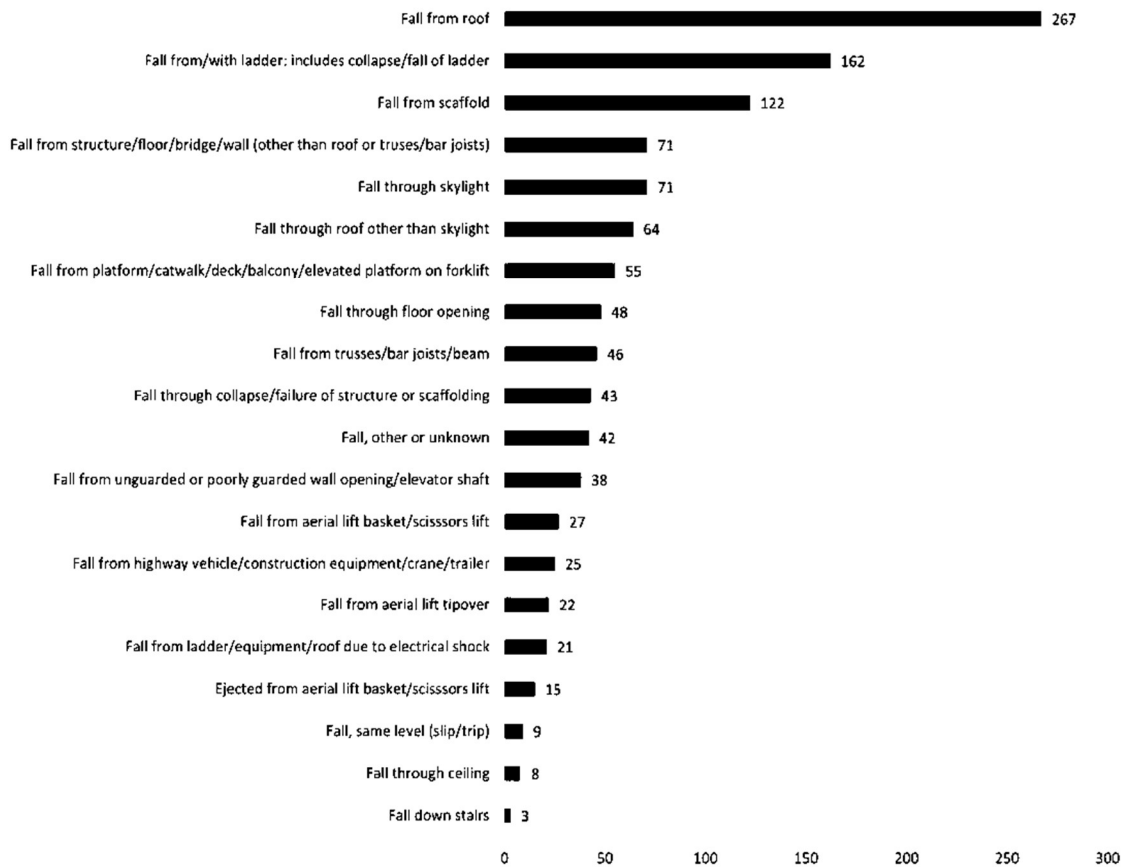
Twenty detailed events for fall fatalities, 2015-2019.

Fall from/with ladder (includes collapse of ladder)
Fall from ladder/equipment due to electric shock
Fall from roof
Fall through skylight
Fall through roof other than skylight
Fall from trusses/bar joists
Fall from highway vehicle/construction equipment/crane
Fall from scaffold
Fall from aerial lift basket
Fall due to being ejected from aerial lift basket
Fall from aerial lift tip over
Fall from structure (other than roof or trusses/bar joists)
Fall by collapse or failure of structure
Fall from platform or catwalk
Fall from unguarded wall opening/elevator shaft
Fall through floor opening
Fall through ceiling
Fall, same level (slip/trip)
Fall down stairs
Fall, other or unknown (not identified by OSHA)

OSHA-Investigated Fall Fatalities

Figure 2 reveals that *falls from roofs* were the most common fatal fall incident investigated by OSHA between 2015 and 2019, comprising 23% (267 out of 1,158) of all fall-related fatalities during that period. Ladder-related falls caused the second-most most fall fatalities, with 162 (14%). Falls from scaffolds caused the third-most 122 (10.5%) fatalities. The top five most common fatal fall events also included falls from structures/floors/bridges/walls (71 fatalities, or 6%) and falls through skylights (71 fatalities, or 6%).

Figure 2. Fatal falls investigated by OSHA, 2015 to 2019.



Fatal falls from ladders averaged 7.24 feet (ranging from 3 to 35 feet), while fatal falls from roofs and scaffolding averaged 24.4 feet (ranging from 6 to 120 feet) and 24.62 feet (ranging from 2 to 130 feet), respectively. Fatal falls were observed across a significant range of heights, with data indicating falls from as low as 2 feet to as high as 500 feet. The average fall height was 28.4 feet. Interestingly, over 76% of the fatal falls originated from elevations less than 30 feet, which is within the 70%-80% range reported in previous research conducted by Huang and Hinze (2003) and Kang et al. (2017). Approximately one-third (33%) of fall fatalities occurred in each of the following height ranges: 1-15 feet, 16-25 feet, and above 26 feet. The percentage of these fatal falls per height group is shown in Figure 3.

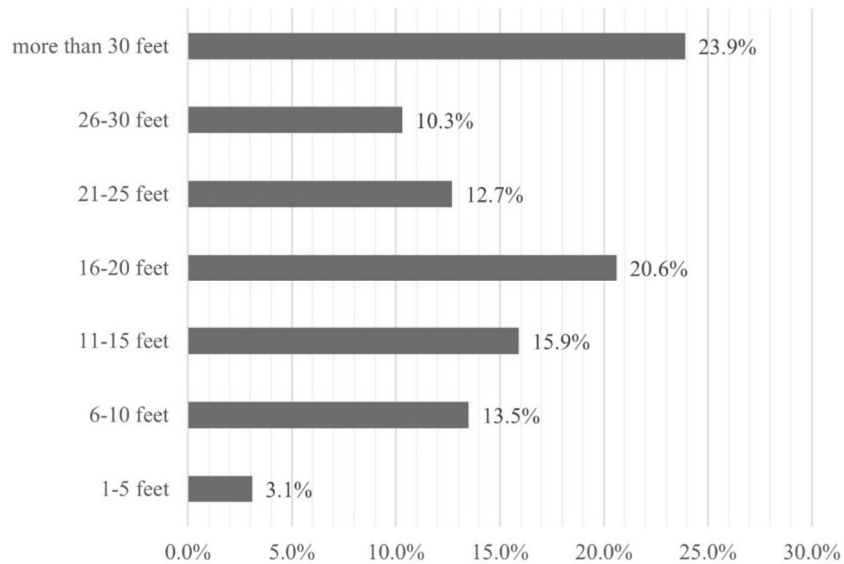


Figure 3. Heights for OSHA investigated fatal falls, 2015-2019.

North American Industry Classification (NAICS)

OSHA's inspection reports show that fifty (50) different North American Industry Classification System (NAICS) codes were associated with at least one fall fatality event between 2015-2019. The top-5 affected contractors and their most common fatal fall events are shown in Table 2. It is worth noting that these five contractors were responsible for over half (52%) of all fall fatalities.

Table 2

Top-5 NAICS numbers for OSHA-inspected fall fatalities, 2015-2019.

NAICS Number	NAICS Description	No. of Fatality Events	Most Common Incident
238160	Roofing Contractors	291, 25.1%	Fall from roof
238130	Framing Contractors	101, 8.7%	Fall from ladder
238120	Structural Steel and Precast Concrete	76, 6.5%	Fall from roof
236220	Commercial and Institutional	75, 6.4%	Fall from roof
238320	Painting & Wallcovering	62, 5.3%	Fall from ladder

Roofing Contractors

Of the 1,158 fatalities investigated by OSHA 2015-2019, 'Roofing Contractors' accounted for over twenty-five percent (25.1%, or 291 out of 1,158 events) of fall fatalities during this time period. Falls

from roofs accounted for the majority (60%) of fatalities suffered by roofing contractors. The remaining causes of roofer fatalities are shown in Figure 4.

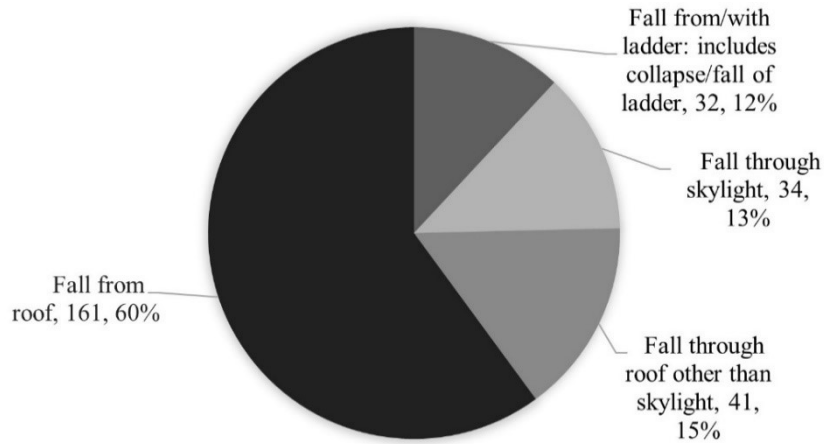


Figure 4. Roofer fall deaths investigated by OSHA, 2015-2019.

Roofing Falls Heights

OSHA inspection data shows that half (50%) of all fatal falls from roofs occur at 20 feet or below, and three-fourths (75%) occur at 30 feet or below (see Figure 5). Fatal falls from roof (all contractors) occurred at heights ranging from 6 feet to 120 feet.



Figure 5. Heights for 'fall from roof' fatalities (all contractors), 2015-2019.

CONCLUSION

The findings of this report highlight the seriousness of fall fatalities in construction and the need for continued efforts to prevent them. The results of this study support the findings of the referenced

studies that *falls* continue to be the number one killer of U.S. construction workers (Brown, et.al, 2021; Huang and Hinze, 2003; Kang et al., 2017). While *crushed-by*, *caught in/between*, and *electrocution* hazards continue to kill many construction workers, *falls* are responsible for over one-third (37 percent, or 1,902 of the 5,172) of all U.S. construction fatalities between 2015-2019. Despite the recurring nature of fall-related fatalities, the construction industry continues to grapple with learning from past incidents and implementing effective preventive measures.

This paper examined the 20 primary causes of fatal falls among U.S. construction workers, as identified by OSHA's fatality investigations. *Falls from roofs* (23% of investigated fatalities) were the most frequent cause of fatal falls, followed by falls from *ladders* (14%) and *scaffolding* (10.5%). Falls from *structures/floors/walls* (6%), and *through skylights* (6%) completed the top-5 most common fall fatalities. Death from a fall can happen at any height. The height from which fall fatalities occurred spanned a wide range, from as low as 2 feet to as high as 500 feet. Notably, approximately 33% of these falls occurred within each of the height ranges of *1-15 feet*, *16-25 feet*, and *above 26 feet*. Though falls from heights under 30 feet accounted for over three-quarters (76%) of the overall fall fatalities, *falls from roofs* generally occurred around the 24 feet elevation on average.

While working at any height is dangerous, this study found that it is especially hazardous for roofing contractors. Fall-related fatalities among roofing contractors accounted for 25% of all such fatalities in the U.S. construction industry, with half of roofer fatalities resulting from falls at or below 20 feet. Other specialty trade contractors, such as framing contractors (8.7%) and structural steel and precast contractors (6.5%) are also very vulnerable to fall accidents.

A critical element of a Safety and Health Program is to proactively identify and assess workplace hazards (OSHA 3885). The 20 different ways workers have fallen to their deaths provide valuable insights into potential fall hazards and can be used to inform preventive measures. Once the hazard is identified, complete *elimination* of any hazard is the most effective methods of reducing hazards for workers. For example, if elimination of the fall hazard is not achievable, then *substitution* by changing work practices for a method less dangerous (i.e., using a manlift vs. ladder) should be considered. Using *engineering controls* such as guardrails to protect workers from a fall over an edge is the third option, followed by providing *administrative controls* for permit required zones (i.e., controlled access zones for roofing). If the fall hazard cannot still be controlled, then providing *personal protective equipment* (PPE) in the form of a harness and lanyard could be used to help protect workers from the fall hazard. However, before hazards can be eliminated/minimized, they must be first identified (NIOSH, 2023).

Falls have long been the leading cause of fatalities among U.S. construction workers. To reverse this trend, it is crucial to identify and effectively control fall hazards. Preventing falls by proactively educating workers about fall hazards and changing cultural norms around these dangers could be the key to reducing the number of fall fatalities. The insights presented in this paper can equip construction professionals and academic institutions with valuable guidance for developing training programs that effectively identify prevalent fall hazards, such as falls from roofs and ladders, and thereby contribute to reducing the frequency and severity of these fatal incidents on construction sites.

LIMITATIONS

While OSHA investigations offer valuable insights into fall-related accidents, their limitations necessitate careful consideration during research. First, OSHA investigation reports vary in detail and

completeness depending on the investigator. This inconsistency and incomplete reports make it difficult to conduct a robust analysis of the data. Secondly, OSHA's limited investigation scope, encompassing only a subset of construction fatalities, restricts the accuracy and comprehensiveness of the dataset. The database indicates that OSHA only investigated 1,158 of the 1,902 (60.1%) fall fatalities between 2015-2019. To address these limitations, researchers should consider using OSHA data in conjunction with other data sources, such as safety audits, worker surveys, and company accident reports.

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